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AUTHOR Zhao, Zhengmai; Hu, Jian
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ABSTRACT

This paper presents an information retrieval system for delivering educational visual materials through the World Wide Web. The system is designed to meet the following user requirements: lecturers prefer direct control over their visual resources; lecturers demand a browser-based interface that will allow them to create and modify their online visual resources easily; and students prefer more approaches to retrieval of information than just keyword search. Topics discussed include: (1) a description of the system, including major features and types of facilities to support information delivery and access (i.e., searching, browsing, and editing); (2) an application of the system to build an online image collection about architectural history that will be used as resource material for courses related to the history of architecture and design; and (3) a database implementation of the system. Two figures illustrate the architectures of the system and the database-based system. An appendix contains sample searching and browsing screens. Contains 10 references. (DLS)

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Supporting Provision and Access of Educational Visual Resources on the Web

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Zhengmai Zhao
Department of Media & IT, De Montfort University, UK
zmzhao@dmu.ac.uk

Jian Hu
Roslin Institute (Edinburgh), UK
jian.hu@bbsrc.ac.uk

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Abstract: Our recent investigation of user requirements show that an easy and direct way for delivering educational visual materials through the Web is strongly demanded by lecturers teaching subjects related to Arts and Design, and that multiple approaches to retrieval of such kind of information is preferred by students. In this paper, we will present an information model to meet the user requirements along with its two implementations: datafile-based and database-based.

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Introduction

Visual materials such as slides and video tapes are vital, particularly in the subject areas related to Arts and Design, to aid the student's understanding of the subject and to engender critical thinking. Normally lecturers who have a large collection of visual materials do not have a convenient way to make them accessible to the students. In most cases, they can be only selectively shown to students during lectures. Even though such materials are sometimes made available through libraries, the number of copies is usually too small to meet the demand, and lecturers may be reluctant to provide such materials in this manner due to the subsequent lack of control over their uses.

Recent advances in information technology especially the World-Wide Web (WWW or Web) have created an exciting opportunity to substantially change this situation. Among its tremendous potentials in a wide variety of areas, WWW is an excellent distribution channel for educational visual resources due to its multimedia/hypermedia ability, platform-independence, and world wide access [Berners-Lee et al. 1994]. Although WWW provides an attractive platform for delivery of educational visual resources, it does not necessarily lead to a successful educational application. Without having a proper information model and a range of tools to support both provision and access of such resources on the Web, the medium may fail.

Our investigation of user requirements has shown:

- Lecturers prefer a direct control over their own visual resources, i.e., the so-called federal manner, than a centralised one, e.g., an imagebank which is created and maintained through a system administrator rather than the resource owners.
- Lecturers, especially those lacking computing experience, demand a browser-based interface which will allow them to create and modify their on-line visual resources easily and without having to learn many technical skills.
- Students prefer more approaches to retrieval of information than just keyword search. This conforms with the research result [Furnas et al. 1983; Gomez et al. 1990] which indicates that keyword search is not always efficient because the user might not know what he/she is exactly looking for or/and because the user may use different words or terms than those used by the

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information provider. The possibility to be able to browse visual resources is strongly demanded as an equally important approach for information retrieval along with the keyword search.

Bearing the user requirements in mind, we investigated a number of projects including ELISE (Electronic Library Image Server for Europe) [Eyre 1994], STILE (Students' and Teachers' Integrated Learning Environment) [Ruggles et al. 1995; Zhao & Patel 1995; Zhao et al. 1996], and the Network Delivery of Multimedia Resources to the Academic Community project (URL: http://WWW.ets.bris.ac.uk). However, no systems have been found which could largely satisfy our user's requirements. They either lack means to allow students to browse the visual resources or means to enable lecturers to supply the resources on the Web easily and in a federal manner. Therefore, the objective of the work reported in this paper is to reduce the gap so as to increase teachers' power to manage and deliver visual materials, and to increase students' power to discover and access visual resources relevant to their learning needs. The remainder of this paper will first provide a description of a system which aims to meet the user requirements listed above. Following that, an application of the system is described as a further illustration of the system functionality. Finally, we propose a new implementation of the system based upon a relational database management system - INGRES.

Description of the System

The system has two major features: allowing provision of visual resources on the Web easily and in a federal manner, and allowing access of visual resources on the Web by both querying and browsing. The system has a client/server structure based on the architecture of the Web. The server basically consists of a Web daemon (e.g., CERN server, NCSA httpd), raw visual resource bases, and a range of tools to support both provision and access of the visual resource. The visual resource bases can be owned and maintained by different providers. A provider can have one or more resource bases. The client basically includes a Web browser (e.g., NetScape, Microsoft Internet Explorer), and viewer applications where needed. It provides interfaces to the searching tool, browsing tool, and the editor. Of course, the editor is available only to the provider. The architecture of the system is illustrated in Figure 1, and each element of the system will be explained in more detail in the following paragraphs.

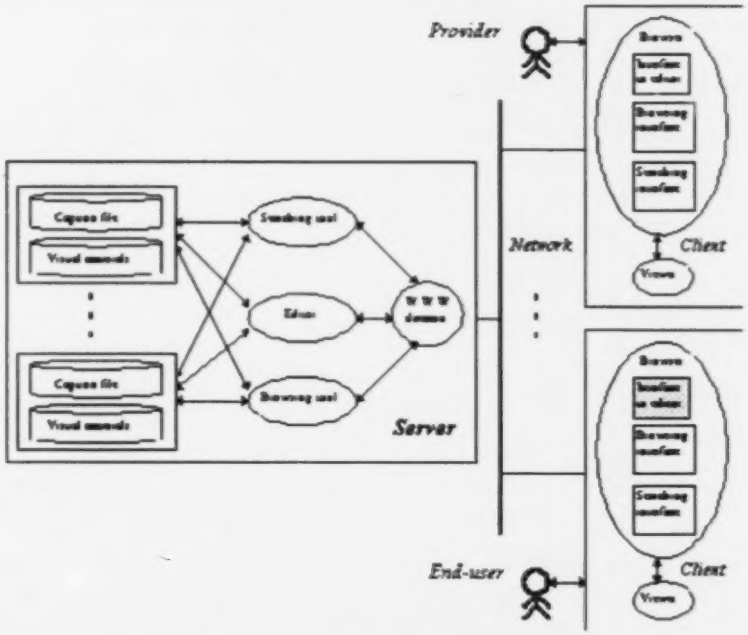

Figure 1: Architecture of the system.

A visual resource base comprises a collection of visual materials (e.g., images, video clips) and a caption file. The visual materials should be in the format the Web can handle, e.g., GIF, JPEG, MPEG. They

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should be placed into the provider's Web directory tree so that they can be addressed as URLs. Textual information of the visual material is stored in the caption file as a set of records. The format of records is defined at the beginning of the file which includes attributes of each field such as title, length, type of content (text or HTML or URL), whether or not it is searchable, whether or not it will be displayed in query results. A collection of visual materials and its caption file are associated with each other via a unique field in the caption file, which holds a URL as its value.

The system provides three types of facilities to support information delivery and access, i.e., searching, browsing, and editing. They are all implemented by means of a combination of FORMS in the Web browser and CGI (Common Gateway Interface) scripts on the Web server. First of all, the editor enables the supplier to define a new caption file, and then to input data into and make changes when necessary to the file, directly through a Web browser. Secondly, the search facility[1] allows the end-user to make a query to the resource base from a Web browser. A query normally results in a list of keywords which represent items matching the query. The user can then choose any of them by clicking it to ask for its more detailed information which contains full textual explanation of the item as well as visual hints (e.g., thumbnails of images) as anchors of the eventual visual material. Finally, the browsing facility allows the end-user to browse a visual resource base according to the hierarchy of classification of the visual material. The classification hierarchy is in fact embedded within the caption file. Once a browsing session is initiated by a user, the browsing tool starts generating and displaying a partial hierarchy to the user step by step following his/her selection.

An Application of the System

The system is being used to build a personal on-line image collection about architectural history[2], which will be introduced to students as resource material for courses related to the History of Architecture and Design. The collection will eventually contain a large number of photographs of structures from a number of different countries. Each photo is attached with a piece of textual information including name of structure, architect(s), location of structure, date when structure was built, type of structure, and its architectural style. In order to build the resource base, the first task was to define the format of the caption file via the browser-based editor. As a result of this, the system created a text file with the specification of how the textual information of images would be stored and treated. In this example, each record of the file comprises six fields corresponding to the items listed above, and a special field with the URL of an image as its value. Among the total seven fields, only the first six ones are searchable, and only the name and location of structure would be displayed in consequent query results as the key of a piece of structure. Having had defined the caption file, the next task was to input the data into the caption file by using the adding function of the editor. Prior to these tasks, the photos had been digitised and stored in the provider's Web directory tree as GIF images.

The appendix displays some screens from a searching session and a browsing session with the current architectural image collection. Screen 1-3 represent a searching session: a user made a query to the collection by entering in the searching interface "Manhattan, New York" and "Domestic" as the location and type of structure (Screen 1); ten items were found in the current collection and the keys of them were displayed to the user (Screen 2); and the user asked to see more about The Dakota Apartment by clicking on its name and its detail was shown with miniatures of its full photos (Screen 3). Screen 4-6, and 3 represent a short browsing session: a user started his/her trip with a list of classifications of structure (Screen 4); he/she clicked "Type of structure" for some reason and was displayed all names of types of structure (Screen 5); he/she was particularly interested in domestic structures so clicked on "Domestic" and all domestic structures were turned up with their key and a thumbnail of a representative photo (Screen 6); and he/she picked up a building for more detail, which happened to be the same one as the previous user chose (Screen 4).

A Database Implementation of the System

A database system consists of a software tool, called a Database Management System (DBMS) and one or more databases that it manages [Date 1990]. A DBMS provides facilities to describe all relevant data in an organisation at a relatively abstract level, or logical level. Application programs usually operate

against the logical data structure while the details of physical data operation are insulated from users.

To allow users or application programs to operate upon the database, a DBMS provides some kinds of interfaces, such as command languages. The most widely used command language for the relational database is the Structured Query Language (SQL) which has a great generality and flexibility to allow applications to retrieve and update the database at a higher level, i.e. without any concern about the physical data manipulation. This is critical if the data structure is complex. Other important features of a DBMS include concurrent data access management, security and integrity control. They make it possible for multiple users to use the database concurrently and securely, so that each user is given the illusion of being able to use data on his/her own.

If a database system is used, it raises a demand for Web to database interfaces. A conventional Web to database interface is usually implemented as a CGI program which contains all data operations and HTML statements, e.g. a C/embedded-SQL program. Problems with this method are mainly related to the interface maintenance. Whenever the interface needs to be changed, the source code will have to be modified and recompiled. Another approach is to adopt a Web to database interface building tool which allows the application user to construct a Web interface through a set of user-customised forms written in an interface tool language. Such a tool language is mainly a combination of HTML statements and SQL-based data manipulation statements, which would be sufficient to describe interface displays and to specify database operations. The WebinTool is such a software package and more details about WebinTool can be found in [Hu et al. 1996].

A prototype with the same functionality described in the previous section but adopting a database approach has been implemented using the INGRES database system and the WebinTool. The system architecture of this approach is shown in Figure 2.

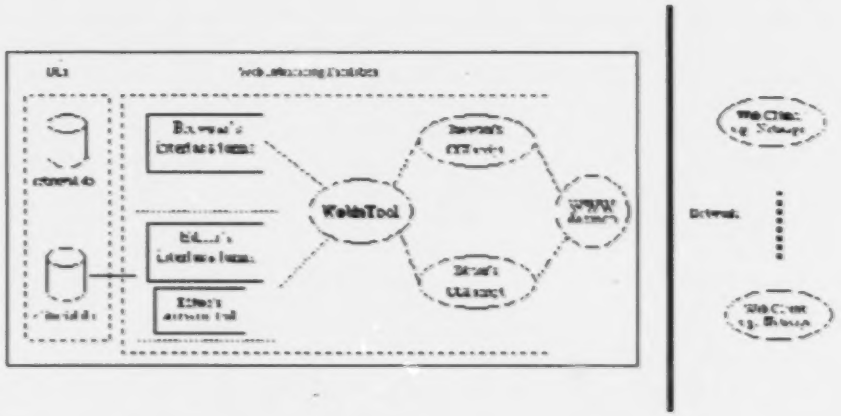

Figure 2: Architecture of the database-based system.

There are two copies of the database: the retrieval one for public use, and the editorial one for the database administrator and data supplier's use. The data in the editorial database is copied onto the retrieval database at a regular interval, e.g. at every night.

The Web interfacing facilities include:

- Web browser: It performs the searching and browsing functions based upon a set of WebinTool forms. A simple CGI script specifies the location of these forms as well as the database environment.
- Web editor: It performs the editing work based upon a set of WebinTool forms, and a security file which specifies the access control. Similar to the browser, there is also an editor CGI script.

Our practice has shown that this framework can effectively and efficiently fulfil the system requirements:

complex data structure can be defined and complex queries (for browsing and searching) can be constructed based on SQL statements; data providers can use the Web interface to manipulate their data conveniently and securely with very little learning; and interfaces can be rapidly built up and easily maintained.

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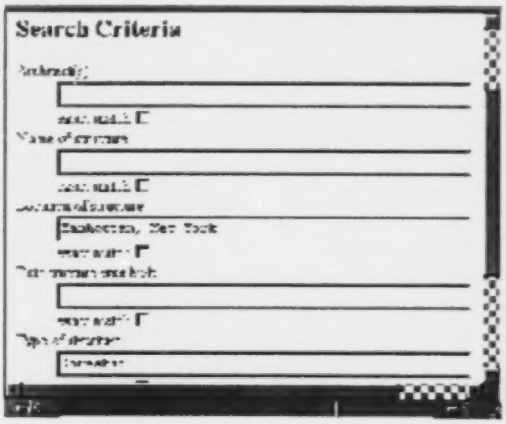
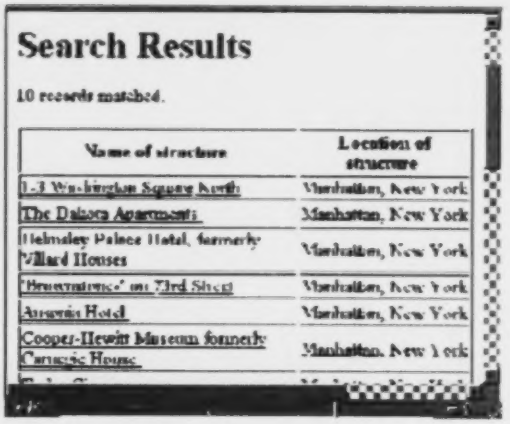
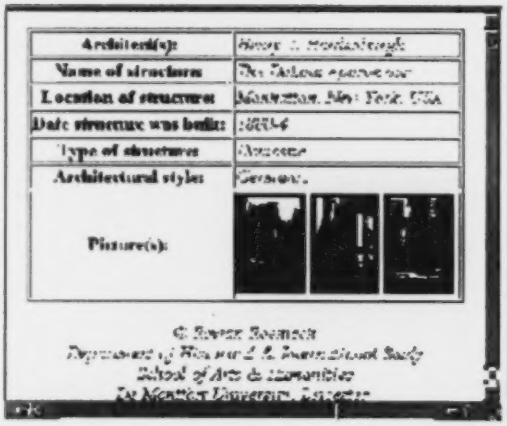
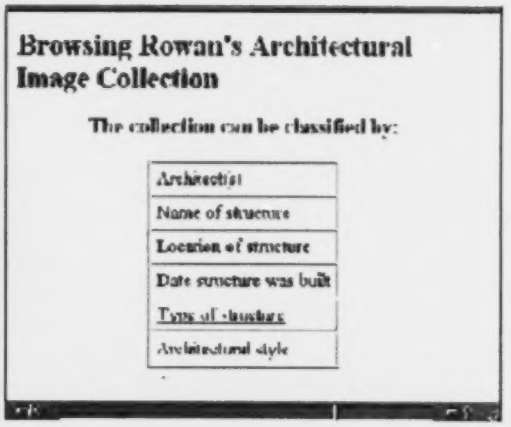
Appendix



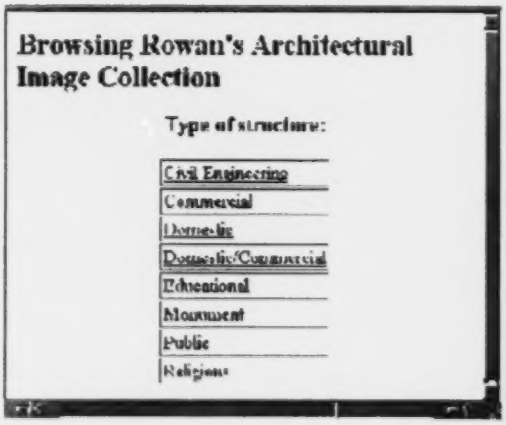


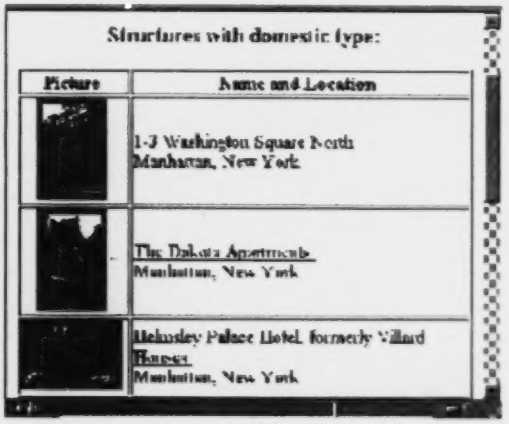
Screen 1 Screen 2





Screen 3 Screen 4





Screen 5 Screen 6

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